SCIENTIFIC AMERICAN

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CALIFORNIA RAISIN CULTURE.

The city of Fresno, California, with a normal population of 20,000, contains in the season 45,000, all working from daylight to dark, engaged in cutting, drying, packing and shipping the crop of raisins. The soil combined with certain essential climatic peculiarities makes the region particularly adapted to the growth of the native grape. For eight months of the year rain never falls. The warmth of the soil absorbed in this long period of sunshine imparts to the fruit that excess of saccharine quality which it requires, while the curing and drying of the grapes in the fields is permitted by the prolonged heat. Added to these advantages is an inexhaustible supply of water for irrigating, drawn from the high Sierras, under the perfect control of the vineyardist and rendering him independent of drought or abbreviated rainfall at all times.

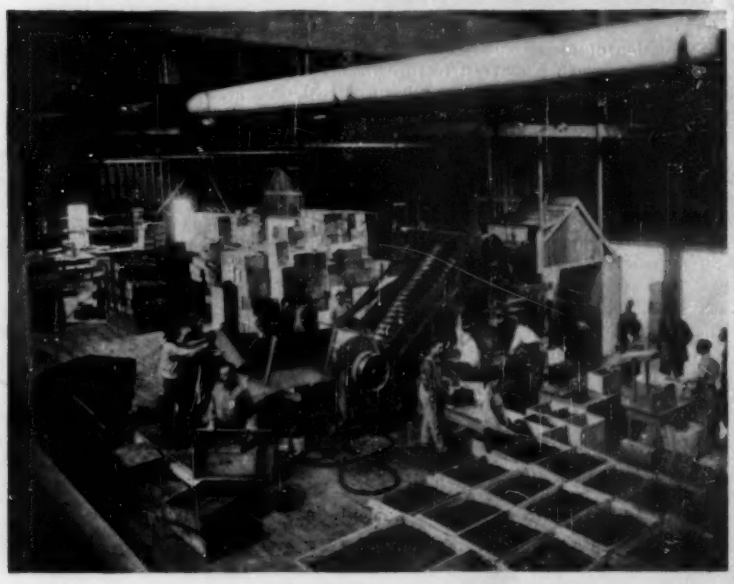
The raisin industry, up to within twenty-five years, was a monopoly of Southern Europe and the chief dependence of a great population. That in so brief a

(Continued on page 8.)

Raisin Vineyard in January, After Pruning.

Raisin Vineyard in March.

Picking and Drying Raisins in the Field.



Stemming and Grading Raisins.

Packing High-Grade Raisins.

Packing Seeded Raisins.

THE RAISIN INDUSTRY OF CALIFORNIA.

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Scientific American.

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RETROSPECT OF THE YEAR 1900.

If it be tried by the test of the number and intrinsic value of the scientific discoveries and mechanical achievements that have been recorded during the past twelve months, the year which has just drawn to a close must be written down as one of the least conspicuous in the last and most brilliant decade of a notable century. Not since we commenced to give our annual review has there occurred a year so barren of sensational developments either in "art, science, mechanics, chemistry or manufactures;" for even in regard to the last named, it must be admitted that our phenomenal prosperity is merely the steady setting of a flood tide, which was running in full volume when last we heard the bells ring out the old, ring in the new.

THE TWELFTH CENSUS.

Among the many evidences of our growth and prosperity furnished by the record of the year, none is more significant than the figures of the twelfth census, which show that the population has grown from 63,069,756 souls in 1890 to 76,295,220 in 1900, a gain of 13,225,465 or 21 per cent in a single decade.

OUR EXPORTS.

The invasion of foreign markets by American exports, which was such a marked feature in the commercial record of the year 1899, has been carried on with increasing vigor during the past twelve months. Gratifying as was the total volume of our export trade for that year, it has increased no less than 28 per cent during the past twelve months, the value of the total exports of manufactured articles for 1900 being $433,851,756. A comparison of the beginning with the end of the century shows that whereas imports for home consumption into the United States for the year 1800 were $52,131,891, at the close of the century they have grown to $685,441,892, an increase of 1,215 per cent, while the total exports have risen from $31,840,903 to $1,293,931,222, an increase of 3,681 per cent. An examination of the details of our exports of manufactures shows that it is in manufacturing and exporting metals that we are chiefly distinguished. The history of nations proves that groups of people frequently excel greatly in certain specified industries, and the growth of our exportation, as well as of our domestic production of manufactures, seems to point to the fabrication of metals as being our most successful line of work, especially at the present time. In 1889, manufactures of metals formed less than 20 per cent of our total exports of manufactures, whereas in 1900 it is nearly 50 per cent. A most interesting fact developed by an examination of our export figures is that the European countries in which manufactures have long been established, furnish as satisfactory a market for our manufactured goods as do the countries where manufacture has not yet been largely developed.

EXPOSITIONS.

France has left its mark on the closing year of the century by an Exposition which was conceived on the broadest lines and carried out with characteristic splendor. The official statistics show that the Exposition was a success, fifty million persons having passed through its gates as against a total of slightly over twenty-five million in the Exposition of 1889. The largest attendance on any one day was 600,000, and the total cost is estimated to have been somewhere between $40,000,000 and $60,000,000. Out of a total of 75,531 exhibitors, 42,790 received awards. The United States obtained 1,981 awards, of which 220 were grand prizes, 486 gold medals and 583 silver medals. Of the foreign exhibitors from the leading nations, the United States were by far the most numerous, the total number being 6,074 as against 3,188 for Italy, 3,113 for Russia, 2,666 for Germany, and 1,688 exhibitors representing Great Britain.

In this country work has been prosecuted with commendable dispatch upon the Pan-American Exposition at Buffalo, the advanced state of the construction at the opening of the new year giving substantial promise that this original and highly artistic conception of the architect and landscape gardener will be fully completed by the time set for the formal opening.

CIVIL ENGINEERING.

Undoubtedly the most important work in contemplation under the head of civil engineering is the proposed isthmian canal to connect the Atlantic and Pacific Oceans. During the year what is known as the President's Commission has completed its labors and presented a report in which it is unanimously recommended that the Nicaragua route be adopted, the scope of the whole scheme being enlarged to include a depth of 35 feet throughout, with duplicate locks, 740 feet, by 84 feet, by 35 feet in depth. The total cost has been raised from the original estimate by Menocal of somewhat over $60,000,000 to a total of $200,540,000.

The year has seen the opening of the Chicago Drainage Canal, 34 miles in length, by which the drainage of the city has been diverted from Lake Michigan to the Mississippi River, and the Chicago River has been transformed from a great open sewer to a stream of fresh running water. Another problem of far-reaching importance is the question of deepening and enlarging the Erie Canal. Early in the year Gov. Roosevelt strongly indorsed the recommendation of a special committee on canals of this State, that the system be enlarged to accommodate boats of 1,000 tons burden, and that the improvements be pushed to completion at a cost of $62,000,000. Special interest attaches just now to this subject, because of the recent completion of the Soulanges Canal, which has been under construction for seven years and has cost $5,270,000, an event which marks the completion of the last link in the chain of improvements by locks and canals of the St. Lawrence River on the Canadian side, the immediate result of which is that vessels 255 feet in length and of 12 to 14 feet draught and 2,200 tons capacity can now pass from the Lakes to Montreal.

Work upon the Croton dam has been prosecuted steadily and the structure is now well above the original bed of the river. The prospects are that by the close of next year this, the greatest dam of its kind under construction, will be completed. Another important scheme of the kind is the Wachusett dam for the supply of the city of Boston, which, while not so lofty or massive a structure as the Croton dam, will serve to impound a larger volume of water. The work of stripping the surface soil and digging the drainage for the dam foundation is now well under way. Work has been actively prosecuted during the year upon the great Nile dam and barrage, on which some 25,000 men are employed. The foundations are now laid, and the superstructure is growing rapidly to its designed level. These magnificent works will render possible the irrigation of a vast area of the fertile Egyptian valley which hitherto has of necessity lain idle. The great Simplon tunnel through the Alps is progressing as fast as men and plant can be crowded upon the work. The total penetration at the present time is about 20,000 feet, and about 12,000 feet of the tunnel has been fully completed.

The construction of the East River Suspension Bridge has made fair progress during the year. The anchorages have been completed, the two main towers have been carried to their full height, and the saddles placed in position ready for the cables, the preparatory work for the stringing of which is now under way. The construction of a third suspension bridge over the East River has been authorized and the plans drawn up. It will be of 1,500 feet span and will be erected near, and approximately parallel, to the Brooklyn Bridge.

The most notable bridge to be opened was the handsome Alexander Bridge at Paris, while in this country another magnificent bridge has been added to the many that span the Mississippi River. This is a steel railroad bridge of the typical American pin-connected type which forms the crossing of the Davenport, Rock Island, and Northwest Railroad. With its approaches it has a total length of 3,157 feet. Another important piece of bridge work was the reconstruction of the famous Kinzua Viaduct, one of the most lofty structures of its kind in the world. The new viaduct replaces an iron bridge erected in 1882. It has a length of 2,100 feet, and the base of the rail is 301 feet 6 inches above the normal level of the Kinzua Creek. Mention should also be made of the strengthening of the historical cantilever railroad bridge across the Niagara Gorge, which in the lapse of time had become inadequate to carry the increased loads of modern railroad traffic. During the summer the Secretary of War accepted the final plans for the proposed memorial bridge to be built across the Potomac at Washington. This truly magnificent structure, should it ever be built, will take rank as one of the finest efforts of the engineer-architect on record, and as a "tribute to patriotism" will worthily commemorate the men who have been distinguished in the foundation and development of the republic.

MECHANICAL ENGINEERING.

In the field of mechanical engineering, the subject which gives promise of attracting most attention in the immediate future, at least in the field of steam engineering, is the development of the steam turbine. Opinions may vary as to the value of its performance when installed in such boats as the "Turbinia" and the "Viper," with which trial speeds of 32¼ and 37 knots an hour were accomplished; but when it comes to be shown that there are turbines which under test have shown as low a consumption of steam as the best forms of multiple cylinder reciprocating engines, it must be admitted that our present standard type of steam engine has a most formidable rival in the field. In recent trials, the 500 horse power Parsons turbine, constructed by the Westinghouse Machine Company, developed at full load a steam economy of 16·4 pounds per electrical horse power per hour, and of 22 pounds per electrical horse power per hour at one-quarter load. The turbine has proved its special fitness as a direct-connected drive in electrical power and light stations, and it is possible that the present year will see it applied to passenger ships of 1,000 to 2,000 tons displacement.

A modification of the steam engine which excited considerable interest was that described in a paper by Prof. E. Josse at the Centennial Anniversary of the Royal Technical High School at Charlottenburg. This consisted in a process for increasing the efficiency of steam engines by utilizing the heat of the exhaust steam for evaporating a liquid having a lower boiling point than water. In the case of the engine described sulphurous acid was used; and the professor stated that a typical compound engine of modern construction which developed 34 indicated horse power under a steady load, showed with the sulphurous acid attachment an increase of 56 per cent in horse power for the same steam consumption, the steam consumption being reduced by the auxiliary attachment from 18·96 pounds to 12·13 pounds per indicated horse power. During the year the work of installing the 6,000 horse power engines and dynamos of the great power house of the Metropolitan Street Railway Company has been satisfactorily carried forward, while the Broadway cable line has been relaid entirely with 107 pound steel, and the necessary changes in the superstructure of both this and the Lexington Avenue line for the change of power from cable to underground trolley have been completed. Another mammoth power house, with an estimated capacity of 100,000 horse power, is being erected at Seventy-sixth Street and East River, for supplying current to the Manhattan elevated railways of this city. A trial train has been tested with good results, and it is expected by the close of the present year the whole of this system will be electrically equipped. The development of the gas engine, especially in the direction of larger sizes, and the practicability of utilizing furnace gases, is concentrating attention upon the possibilities of the gas engine as a direct rival of the steam engine and water power. A recent review of the comparative cost of the three systems has shown that the best results actually recorded for water, steam and gas power give for the first a cost of $6.25 per hour per annum; for the second, $20 per hour per annum; while in Germany, with gas engines using furnace gas, the lowest estimated cost is $20, and in England, with the use of the producer gas, the lowest estimated cost is $25 per hour per annum. The water turbine is to-day the cheapest of our prime movers, except when the first cost of the hydraulic plant is heavy or the transmission line exceeds a certain length, when the difference in the relative cost of the three powers gradually disappears.

The water tube boiler in a variety of forms continues to demonstrate its superiority for certain classes of work, and although it may seem to have been something of a failure in the British navy, the result of the present searching inquiry which is being made by a special board will doubtless develop the fact that the failure has been more one of handling than of design or construction. The Scotch boiler still maintains its ascendancy in the merchant marine, and, where it is associated with heat at forced draught, it shows an economy of fuel which cannot be approached by the water tube type, as witnessed in the daily record of the Hamburg-American liner "Deutschland," where the consumption of fuel per indicated horse power per hour for the main engines has fallen to 1·33 pounds.

ELECTRICITY.

In the electrical world progress has been made chiefly along familiar and well established lines. Considerable advance has been made in telephony and telegraphy, and more particularly that branch of the latter which is associated with the name of Marconi and his fellow workers. Marconi's efforts have been directed more to synchronizing his messages and constructing a transmitter, the messages from which can be recorded only by the apparatus which has been tuned to receive them, and he appears to have successfully solved the problem. The Pollak-Virag rapid electric and photographic telephonic system is reported to have given phenomenal results, notably in a test between Berlin and Ofen-Pest, when a message of 220 words was transmitted in nine seconds, the development of the sensitive paper requiring between 4 and 5 minutes. Another most important development is to be recorded in Dr. Pupin's system of long distance telephony, in which, by the introduction of inductance coils, it is possible to make an extraordinary increase in the distance over which telephonic messages may be sent. Dr. Pupin established the correctness of his theories by means of 250 miles of artificial lines arranged with

inductance coils. Another notable contribution to telegraphy is that of Donald Murray, an Australian inventor, whose high-speed page-printing telegraph has shown a capacity, with the Morse telegraphic key, of 50 words, and using the Phillips code, of 65 to 70 words per minute. The Paris Exposition served to introduce to the public the Poulsen telephone, in which magnetic pulsations are caused to act upon a steel wire, and the magnetization as thus effected is conversely caused to act upon the telephone receiver and to reproduce the original sounds.

During the year the work of utilizing the water power of the world has been proceeding apace. The 50,000 horse power plant at Niagara is being exactly duplicated by the construction of a second 50,000 horse power wheel-pit on the opposite side of the canal. There is nearing completion at Massena, N. Y., another of these vast hydraulic electrical enterprises. As much of this plant as will be completed next year will have a capacity of 37,500 horse power, and the extension which is immediately to be made will bring up the equipment to 75,000 horse power. Another great plant of the kind is that which is known as the Sault Power Canal, where a vast power house 1,400 feet long is being constructed, in which 60,000 horse power will be developed on 320 turbine wheels. In this connection mention should be made of the hydraulic system of air compression, which is nothing more or less than a modern development of the ancient Catalan furnace water blast. Several plants of the hydraulic-pneumatic type are in course of erection, in which air pressures will be developed of from 25 to 85 pounds per square inch, the depth of the shaft in one case being 203 feet and the diameter of the compression pipe 13 feet.

During the year some most important electrical traction schemes have been either commenced or completed. The most notable of these is a $35,000,000 contract which was let early this year for the construction of 20 miles of subway and tunnel in this city. This is by far the largest contract of the kind ever undertaken, and when the work is completed, which will be in about four years' time, New York will possess the most perfect rapid-transit system in the world. The year has seen the opening of electrically-operated underground railways in London and Paris, both of which have thus far proved to be an unqualified success, while at the close of the year comes the announcement that the celebrated Metropolitan Underground Railway, of London, is at last abolishing its steam locomotives and substituting electric traction.

TRANSPORTATION.

So great has been the increase in the application of electricity that much that might have been said under the head of transportation has been anticipated under electrical traction. The steam railroad, of course, easily maintains, as it will long maintain, its position as the chief method of long distance transportation. The total length of our railroads is now 190,833 miles, an increase for the year of 3,981 miles. Great as were the locomotives and cars in 1899, they have increased in 1900, until the heaviest locomotive now weighs 125 tons and has a net hauling capacity on the level of 10 miles an hour of 7847 tons. The Paris Exposition brought before the public a certain number of "freak" locomotives, but on the whole the designs were of great merit and showed that the national types of locomotives are gradually approaching a common standard. Thanks to the Camden and Atlantic City trains, the credit of running the fastest trains in the world is still due to this country, although the French railroads have the greatest total number of long-distance fast expresses. The Camden-Atlantic City trains are run at a speed of 64·3 miles an hour. The fastest long distance train in the world is the Orleans and Midi train from Paris to Bordeaux, which covers a distance of 486¼ miles at a speed including six stops of 54·13 miles an hour. But little has been heard of the steam electric locomotives of French design, and it is likely that even less will be heard in the future. Experience during the year with the compressed-air cars which are being run on cross-town lines in this city has not been such as to give any emphatic promise of the extension of this system in the future, although we believe that the Hardie cars which are at present employed are giving fair satisfaction. Experiments are now being carried on with a superheated water motor of improved design, in which, instead of taking steam from the top of the hot water storage tank, hot water is taken from the bottom of the tank and expanded into steam in the cylinders. No records of the tests of this motor, which are being made on a New York suburban line, are yet available. A somewhat ambitious attempt to produce a satisfactory single-rail suspension railroad is the structure which has been built through the Wupper Valley between Barmen and Elberfeld, Germany. This is a double track elevated road, with cars suspended from electric trucks. The motors are of 36 horse power, and the maximum speed between stations is to be 25 miles an hour.

BICYCLE AND AUTOMOBILE.

There is evidence that the so-called bicycle craze is over and that this most useful device has now taken its place as one of the regular means of transportation and as a source of healthful recreation when used with proper discretion. It has evidently reached its standard form as to general proportions and details, and we must look for novelties henceforth in the direction of the motor bicycle, which is probably destined to enjoy a fair measure of popular favor. The development of the automobile proceeds apace, the improvements being in the direction of reducing weight and giving increased rigidity where experience has shown it to be needed. Just now in this country the different varieties of steam-driven automobiles seem to be exciting more interest than any other type, although it is likely that the different forms of motors (electric, gas and steam) will each have their own particular sphere of work, the electrically-driven automobiles being popular for city and suburban use, and the gas and steam-driven machines for country use and extended touring. The efforts of the builders of electric automobiles are directed to the improvement of storage batteries in the way of reducing the weight and increasing the capacity; and the indications are that in the near future electric automobiles will be on the market which will have a capacity of from fifty to seventy-five miles at a single charge. The gas-driven machines have the advantage in radius of action over any others, while the makers of steam carriages are looking for a suitable condenser, which shall enable them to use the same charge for water continuously.

NAVAL.

The close of the year finds the United States navy occupying the same relative position among the navies of the world that it did twelve months before, and indeed, if anything, our standing as the fourth in rank is somewhat strengthened. The settlement of the unfortunate armor-plate controversy has enabled the government to make contracts for the construction of no less than fourteen warships of the largest size in their respective classes, all of which have been illustrated in recent issues of this journal. Among these vessels are included the five battleships of the "Georgia" and "Rhode Island" classes, of 19 knots speed and 15,000 tons displacement. The six armored cruisers of the "California" and "Maryland" types are of about 14,000 tons displacement and 22 knots speed, and three protected cruisers of the "St. Louis" type are 9,700 tons displacement and 22 knots speed. All of these ships are to be armored with Krupp steel, and they will carry guns of the 45 and 50 caliber type which have recently been tested at Indian Head with such splendid results. During the year the "Albany," which was purchased during the war with Spain, has been completed and is now in commission, and the battleship "Kentucky" has also been commissioned, while several of the new torpedo boat destroyers have either been completed or are getting ready for their trials. The four new monitors and the six semi-protected 16½ knot cruisers are still under construction, and there is the same satisfaction in knowing the objectionable features inherent in vessels of both classes, in the way chiefly of their slow speed, are somewhat offset by the excellent quality of the armament which they will carry, the four monitors each mounting a pair of new 12 inch guns, which lately showed at the proving ground a muzzle capacity of about 48,000 foot-tons. In a general survey of the navies of the world perhaps the most striking fact is the great increase which is taking place in the speed of all classes of warships. Among the smaller vessels the "Viper" and the "Cobra," each propelled by Parsons turbines, stand first with an official record of 36½ knots per hour, the "Viper" having covered a mile at 37·1 knots per hour. Eighteen and 19 knots have come to be the accepted speeds for battleships, while 23 knots is the speed required in the modern armored cruisers. The protected cruiser seems to have fallen quite into disfavor, and all vessels of the cruiser class are now protected with a belt of armor at the waterline. In spite of the comparative failure of the "Belleville" boiler in the British navy, it is likely that the water tube boiler as such will be used exclusively on all future warships.

MERCHANT MARINE.

In the annals of the merchant marine the closing year of the century will be memorable for the truly splendid performance of the great liners which ply between the old and the new worlds. Whatever may be said of the folly, the cost and the risk of running at speeds of 22 to 24 knots per hour across the Atlantic, there is no question that the general public is deeply interested in such performances, and that the traveling public patronizes these fast vessels. The notable ship of the year has been the Hamburg-American liner "Deutschland," which commenced to make new records on her maiden trip and was the first to maintain a speed of 23 knots an hour from port to port. The fastest passage made by this vessel was an eastward trip from New York to Plymouth, the voyage being made at the rate of 5 days, 7 hours and 38 minutes, at an average speed of 23·36 knots an hour. The average indicated horse power of the whole trip was 36,913, and the consumption of coal including the auxiliaries of 1·45 per horse power per hour. Two fast steamships are building for the North German Lloyd Company, one slightly smaller than the "Deutschland," but designed to be about the same speed, and the other to be about 706 feet long and to have 38,000 horse power and a sustained sea speed of 23·5 knots. There is also good reason to believe that one of the English companies has also under consideration a pair of fast ships with which an attempt will be made to win back from the German companies the distinction of owning the fastest ships on the Atlantic. As distinct from these fast vessels there are being placed upon the Atlantic in increasing numbers ships of the "Pennsylvania," "Cymric," and "Ivernia" type, vessels of over 20,000 tons displacement, moderate speed, and large cargo and passenger capacity. There is no doubt that each type has its sphere of work and that neither type will become predominant to the exclusion of the other. Although the coastwise and lake shipping of the United States is enormously prosperous, there is no evidence as yet of any great revival in our deep-sea shipping, the cheaper cost of construction and operation of the foreign ships making it impossible for the United States to compete successfully in the deep-sea carrying trade. The Subsidy Bill now before Congress would seem to be an absolute necessity to assist our shipping interests (at least in the early years of its struggle) in regaining its former proud position.

AERONAUTICS.

The past year has been a notable one in many respects in the field of aeronautics, where interest has been greatly stimulated by the competition for the Henri Deutsch prize of $20,000 which has been offered for the best dirigible balloon. At the present time three balloons of this type are receiving their finishing touches at Paris preparatory to entering the contest, one for M. De Santos-Dumont, another for M. Aime, and a third for M. Roze. The Santos-Dumont balloon consists of a cylinder below which is suspended a trussed frame which carries the motor, the propeller and the operator. That of Roze consists of two cylinders placed side by side in the same horizontal plane, with the operator's car suspended between them, the ascent and descent being controlled by vertical propellers operated from the motor that drives the horizontal propellers. Much has been heard during the year of the Danilewsky machine, which has been built under the auspices of the Russian government. It consists of a vertical cylindrical balloon below which is suspended a series of controlling planes and the steering and propelling mechanism. The inventor claims particular advantage in this type in respect of controlling the ascent and descent, particularly the latter. The greatest interest of the year attached naturally to the Brobdignagian balloon of Count Zeppelin, which is 38 feet in diameter and has the enormous length of 416 feet. In the latest trials it was shown that in a breeze of moderate strength, the inventor is able to control the vast structure, rising, descending, and performing various aerial evolutions with apparent ease; but nothing was done, or has yet been done by any balloon, to show that it is possible to control an airship, whether of the balloon or aeroplane type, in every kind of weather, and propel it against the strongest winds. Progress in the field of aeronautics is slow; but when we keep in view the enormous difficulties of the problem, it is perhaps as fast as can reasonably be expected.

MISCELLANEOUS.

Limitations of space prevent any extended reference to many events of the year which are of distinct importance. Exploration, both Arctic and Antarctic, is being carried on or projected with a zeal and liberality which has never before been witnessed. Peary is still in the far North engaged in establishing his line of communications, from the extreme outposts of which, with a few chosen companions, he will make his final dash for the pole. The intrepid explorer had met Sverdrop, who has taken Nansen's ship, the "Fram," into the Arctic seas. The latter is supposed to be now wintering in Jones Sound, and it is supposed that Peary is wintering at Fort Conger. Letters have been received from Peary dated March 31, 1900, in which he stated that he was in good condition and that he would push on from Conger in the hope of accomplishing his task by last spring, and making his return during the past summer; these letters were written to Mrs. Peary, who has started to join her husband. Of the fate of Andreé nothing is known; the possibility of his return is now considered to be very slight. What is known as the Jesup North Pacific Expedition has started for the northeastern part of Asia for the exploration of the country northeast of Amoor River. An expedition has been planned which, under the direction of Herr Von Drygalski, will start at the end of August, 1901, for the magnetic and meteorological exploration of the Antarctic regions; and the steamer "Southern Cross," with Borchgrevink and the survivors of the southern polar expedition, returned during the year to New Zealand, with the important announcement that the magnetic pole had been located.

A PYROTECHNIC FIRE-ALARM.

A pyrotechnic fire-alarm torch which is electrically ignited, is an invention which we have selected this week for illustration. The inventor of the alarm is James C. Moore, of Philadelphia, Pa.

In a non-combustible shell a slow-burning material is placed. On this shell a combustible cap is supported; and in the cap pyrotechnic material is packed, which rests upon the slow-burning material of the shell. Within the torch thus constituted a fuse is arranged. The fuse consists of two metallic stripe forming the terminals of an electric circuit. A fuse embedded in the pyrotechnic material joins these strips, which fuse becomes highly heated by the current.

The torch is secured to the roof of a building or in any place where it may be seen. The metallic strips are connected with push-buttons and thermostats distributed throughout the building. The circuit is completed either manually by means of the push-buttons, or automatically by means of the thermostats when the temperature becomes excessive.

When the circuit is thus completed, the fuse is heated to redness, the pyrotechnic material is exploded, thereby forcing the cap off the shell and igniting the slow-burning material.

A PYROTECHNIC FIRE-ALARM.

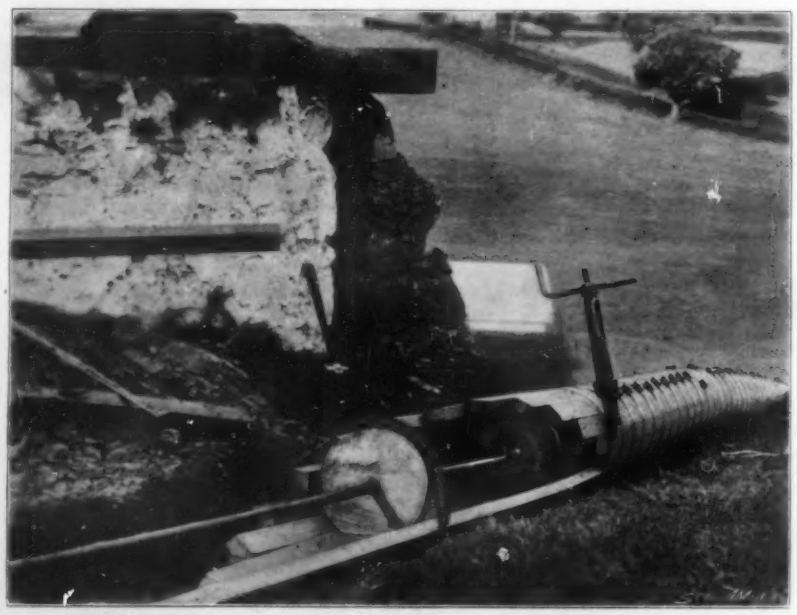
METHOD OF CONSTRUCTING WOODEN WATER-PIPE.

The accompanying two photographs illustrate an installation of wooden piping for carrying water to a farm for driving a mill, and for pumping, by hydraulic means, a supply for nine different farms, the most distant farm being 3,000 yards away, while the height above the pumping engines is 200 feet. The piping was erected upon the estate of Mr. Harry Buddicom, an engineer in Wales. It was constructed by three men at the rate of 15 yards per day. All the tools for building it were made by the carpenter and blacksmith employed upon the estate and cost only $10. The pipe is in two lengths. The section shown in the second illustration crosses the valley and is 80 yards in length, while the other photograph illustrates the section that runs from a tank at the top of the hill to the mill wheel at the bottom, a distance of 120 yards. The total cost of building the piping was less than half of what it would have been had cast iron pipes been employed.

The pipe is 10 inches in diameter, internal measurement, and was constructed of pitch pine segments. These had to be perfectly clear of knots. The circumference of the pipe contains sixteen segments, each measuring 16 feet in length by 1¼ inches in thickness. The exterior surface of each segment is milled, but the inside surface is left flat. At regular distances of one foot, the pipe is banded with a length of hoop iron, to keep the segments firmly in position. The segments break joint evenly from one end to the other, and there is only one segment butt jointed under each band. The butt joints are made tight with a short length of common blind cord kept in position with two small wire nails. Each segment when driven home compresses the cord after two or three bands have been placed upon it. The pipe is quite tight under a pressure of 35 pounds per square inch, and it is always full of water.

The pipe was constructed as follows: First, 16 segments, each measuring 16 feet in length, were taken and cut in two pieces of graduated lengths. That is to say, the first segment was cut in two, each piece of which measured 1 foot and 15 feet respectively. Then the second segment was similarly divided, only this time one piece measured 2 feet and the other 14 feet; the third segment cut into two pieces measured 3 feet and 13 feet respectively, and so on until the whole 16 segments had been so cut. These 16 pieces of segments, varying from 1 foot to 16 feet in length, were then taken to the point where the pipe finished, since they were required to complete the pipe. The remaining 16 pieces of segments were all rabbeted at one end, so that when fitted together they were readily driven tightly into an iron ring or the end of the iron pipe connecting with the mill. When this was accomplished there was a piece of pipe, the joints following spirally round the circumference, beginning with the first 1 foot long and ending with the last segment next to it, 16 feet in length. Our first illustration will comprehensively convey the idea as to how this principle was carried out, by the varying lengths of the segments.

When the pipe had been commenced, the core or expanding mandrel, which constituted the centering upon which the pipe was built, was inserted. This core had sixteen segments expanded by means of a cone with a handle of sufficient length to clear the last segment. The core when it was contracted fitted loosely into the pipe and had a tail so that it could be kept true with the bore of the pipe. About six feet in front of the core was a disk with a coil spring adjusted around it, which was supplied so that a segment could be inserted in its place between the disk and the spring which serves to keep it in position. The mandrel was then brought opposite the shortest segment and expanded. A segment was slipped in, the band fastened round, and as it was tightened the core contracted so that the segment slipped easily into its proper place. When the tightener had sufficiently tightened the hoop-iron band, the exterior surface of the pipe was rendered as smooth and as true as if it had been turned with a lathe. The core was then moved forward a foot to the next butt joint, when the process was repeated, and so on until the end of the pipe was reached, when it was brought to a perfectly straight edge by means of the pieces which were cut from the first segments. This is one of the first instances of this system of construction in Great Britain, though it is common in the United States.



WOOD-PIPING—EXPANDING-CORE TIGHTENER AND PRINCIPLE OF CONSTRUCTION.

WOOD-PIPING—COMPLETED SECTION ACROSS A VALLEY.

New System of Refuse Furnace.

Among the different systems of refuse-consuming furnaces which are now being tried in Europe, that of Veidenbrück and Wilms, recently installed at Cologne, seems to have proved satisfactory. In this furnace, the grate bars are formed of sets of hollow cast iron tubes or conduits, arranged one above the other in pairs, the rear ends being fastened together and made tight by asbestos joints. The air penetrates by one end of the system, traverses first the upper tube, then the lower. The extremity of the latter is closed, but has a great number of side perforations directed toward the top, by which the air escapes into the combustible. To form the grate, a number of such sets of bars are placed side by side and united to an air chamber. If the grate is large, the air chamber is placed in the middle and two ranges of bars, one front and one in the rear, are used. The bars are sometimes three feet in length, so that a grate six feet deep is thus formed. The air chamber is connected with a blower, etc., which forces the air through the system. The air thus cools the bars and becomes itself heated, and coming out at a high temperature, it aids in the combustion. The bars, being kept cool by the air circulation are not as rapidly destroyed. After some preliminary trials, four of these furnaces were installed at Cologne. The blowing fan was operated by an electric motor. It was found, however, that the projection of dry air caused the burning of the dust at too great a temperature, which favored the formation of scoria, and thus the air holes became stopped up. It was remarked, however, that the bars remained cold. Some experiments were tried in which steam was introduced into the tubes, and these succeeded so well that a steam system was substituted for the fans, consisting of four tubular boilers of the Dürr system, each having a heating surface of 2,158 square feet. The system has given excellent results; the grate bars, after 4,000 hours' working, show no trace of usage, and the dust burned was of a very inferior quality, without the addition of other combustible.

AN extensive botanical garden has recently been laid out at Dahlem, a village within easy distance of Berlin, which possesses some novel features. It is situated in very rough country, and unique advantage has been taken of this fact by reproducing, as far as possible, the natural scenery from which the various specimens of flora have been collected from all parts of the world. By this means a more comprehensive idea is obtained of the native habitat of the plants and trees, and the conditions under which they thrive.

A WONDERFUL CLOCK.

William L. Bundy, the inventor of the Bundy time-recorder, has completed a most ingenious clock, on which he has been at work for many years.

The clock stands nine feet high and is inclosed in a case of quartered oak, carved and finished entirely by hand. The hour and minute of the day, day of the week, day of the month, day of the year, and the year, are told by the clock. The phases of the moon are given, and the shape of the moon each day is shown. The clock also gives the seasons of the year, strikes the hour and plays a tune each hour, giving six distinct changes of tune and playing them consecutively.

The mechanism of the clock sets in motion a small steam engine and dynamo machine. It also chimes the bells placed around the dial at a quarter past the hour over and back once; half past, over and back twice; and at three-quarters, over and back three times. The small figures—a band of soldiers—in the "grotto" operate each quarter of the hour, and simultaneously an "old-fashioned sawmill" is set in motion, sawing through a log, the carriage returning ready for another cut. The water can be seen running down the flume. At the same time a bell in the dome at the top of the clock will toll, calling attention to the mill in operation. Beneath the mill is an artificial pond, containing fish of different kinds, frogs, turtles, shells, etc. There is also a boat floating among the logs on the surface of the pond.

The entire mechanism is built in skeleton form, and every part is visible from the front and sides. The mechanism is driven wholly by the clock movement, operating the various sets of complicated levers and cams. It has to be wound up once a week in five different places. The wheels revolve at a rate of speed varying from six hundred revolutions a minute to a revolution once in ten thousand years. These wheels are operated in such a way as to make the calendar perpetual, giving each month at its proper time and the correct number of days to each month, including leap year; and the year changes correctly at leap year, when an extra day is added.

That the sound of the music and chimes may be heard, a panel is automatically opened at the bottom of the upper case when the music starts to play, and is closed when the music ceases. Although the music, the chimes and the sawmill operate all automatically on the quarter of the hour, they may be set in motion at will by buttons on the outside of the case.

Mr. Bundy began work on the clock in 1878, when he was in the jewelry business in Auburn. He completed the upper part of it without the sawmill and pond and placed it on exhibition in his store window. Then it was considered so much of a curiosity that for a long time it was necessary to have a special detail of police to keep the crowd moving. Since then he has entirely remodeled the clock and added the sawmill and pond.

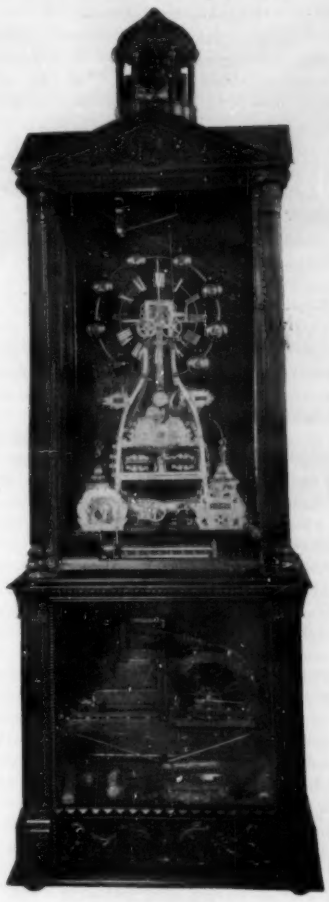
A NEW INDUCTION COIL.

BY PROF. W. C. PECKHAM.

When the discovery of the Roentgen rays was announced five years ago, the induction coil was in the condition in which it had been for many years. There had been no demand for its development. It was regarded as an instrument for the display of certain striking and beautiful electrical effects, but of little value even for purposes of instruction. All that was very quickly changed. It was the good fortune of the writer to have, at that time, in the cabinet of apparatus belonging to his department of instruction, a very fine coil made by the son-in-law and successor of the famous Ruhmkorff in Paris. He had also a very excellent series of Crookes tubes recently purchased to exhibit their beautiful phenomena, so that he could go immediately to work to investigate in the new field. The induction coil is the best means of generating the X-ray and is indispensable for transmitting messages by wireless telegraphy. Its importance is greater now than it ever was before.

Up to the time above alluded to, coils had been limited to a spark length of about 15 inches. There had been one remarkable exception, the coil made by Mr. Apps, and usually spoken of as the Spottiswoode coil. The total length of this coil is 4 feet; its external diameter is 20 inches. The core of the primary is 44 inches long, 3·56 inches in diameter, and its weight is 67 pounds. The primary was of copper wire nearly $\frac{1}{8}$ inch in thickness. It had 1,344 turns and was wound in six layers 42 inches long. There was another smaller primary, but it was not used for long sparks.

The secondary coil contained no less than 280 miles of fine copper wire wound in four sections, and forming a cylinder 37½ inches long and 20 inches in diameter. Two sizes of wire were used in the secondary, the outer sections at each end being of thicker wire than the inner sections. The secondary contained 341,850 turns. With 30 cells of Grove battery it gave a spark of 42½ inches, by far the largest spark of electricity artificially obtained up to that time. This coil was made about twenty-five years ago, and is said to



AN INGENIOUS CLOCK.

be greatly deteriorated at the present time. Its proportions have been given for the sake of comparison with those of the coils described below. They are very different from the best practice now.

Some seven years ago Prof. Elihu Thomson published an account* of his high frequency apparatus, by which, with an alternating current dynamo as an exciter, he produced a spark 64 inches in length. The work of Prof. Trowbridge at Harvard University with his enormous battery has been described in these columns. Both these experimenters employ an extraordinary source of power and obtain results which have not been equaled elsewhere.

SPARKS 32 INCHES LONG.

There have recently been exhibited in New York city two new and very remarkable induction coils. They are of the old pattern, but of new proportions, and give results which seem to demonstrate the claim of their designers that they are a very great advance upon their predecessors. Our illustration shows the external appearance of the coils, for they are made exactly alike. They have been made by Queen & Company, of Philadelphia, for the Japanese government, and are to be used for wireless telegraphy. The largest coil which this firm has hitherto built has been one of a spark length of 25 inches. Considerable experimental work was necessary to determine the proper proportion of the various parts of the new coils.

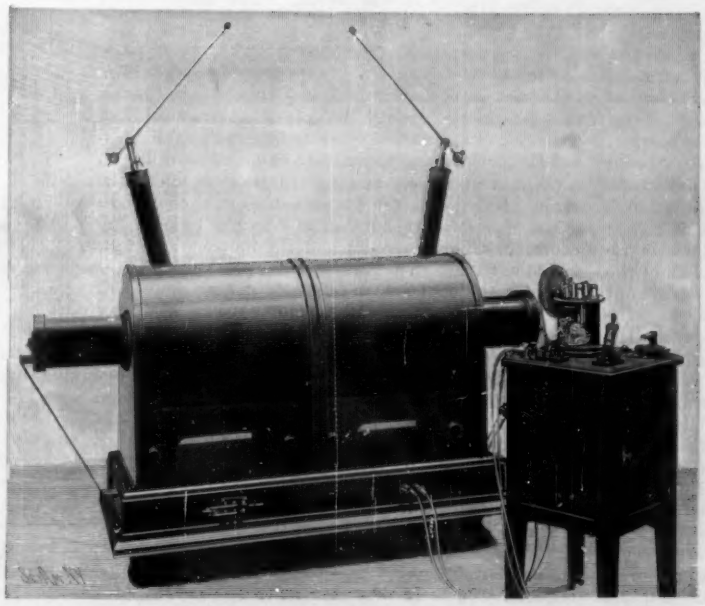
In these coils the core of the primary is as usual composed of iron wire wrapped into a bundle about 5 inches in diameter and 4 feet long, weighing over 200 pounds, or almost five times as much as that of the Spottiswoode coil. The general method of mounting may be easily made out from the engraving. The secondary contains about 100 miles of fine insulated copper wire, wound in a very great number of small sections. It will be seen that the secondary is divided in the center, making two distinct and separate parts on separate spools. This is done simply for convenience in handling, since each part is easily removable for transportation.

The form of the secondary is very unlike that of its great predecessor. The proper position and size of the coils of the secondary were carefully determined by experiment and measurement of the magnetic flux, and as a result of this investigation these coils will give a spark of 45 inches in length with 100 pounds of secondary wire, as against 280 pounds in the Spottiswoode coil. It will be observed that the iron core extends nearly a foot beyond the secondary spools. These spools are about 15 inches in external diameter. The exact shape of the secondary winding is not stated, but it may be stated that it is not cylindrical, and is deeper toward the center.

The circuit breaker and condenser are placed in an auxiliary piece of apparatus, seen to the right of the coil. The break is accomplished by an electric motor moving very heavy pieces of platinum, which separate under the surface of a liquid. The speed of the circuit breaker may be varied through wide limits. The condenser is divided, so that it may be adjusted to the capacity of the circuit. By grounding the center of the secondary upon the primary, the potential between the primary and the secondary cannot rise higher at any point than is represented by a spark of 20 inches. The poles of the secondary are heavily insulated, and are inclosed in hard rubber tubes which extend to a safe distance above the coil.

When used in connection with a storage battery giving 25 volts and 20 amperes, a very heavy secondary spark, representing hundreds of thousands of volts, is produced between the terminals when they are separated 45 inches. When used to give sparks between 25 and 35 inches in length, and when the circuit breaker is run at comparatively high speeds, a great number of sparks will pass between the terminals, and this is clearly seen in the small engraving, which shows the spark points separated about 32 inches.

The results which will be obtained in connection with wireless telegraphy experiments can only be conjectured, inasmuch as no such spark length has been heretofore obtainable for use in connection with this work. It is thought, however, that owing to the peculiar nature of the long spark produced by these coils, the distances over which messages can be sent will be greatly increased.



LARGE INDUCTION COIL MANUFACTURED IN PHILADELPHIA FOR THE JAPANESE GOVERNMENT.

THE export of British rails has considerably diminished during the first nine months of the present year, since the aggregate quantity dispatched abroad is only 277,809 tons, as compared with 354,737 tons for the corresponding period of last year, a decrease of 76,928 tons. The most serious reductions are those of British India, where the demand has fallen by 48,248 tons; Norway and Sweden, by 40,703 tons; Canada, by 16,759 tons; China, by 8,915 tons; Brazil, by 6,358 tons; Egypt, by 4,672 tons. On the other hand, the exports to the Argentine Republic have increased by 17,052 tons; Australasia by 11,268 tons; British South Africa by 10,111 tons; Japan by 9,000 tons; and Mexico by 7,078 tons.

*See SCIENTIFIC AMERICAN SUPPLEMENT, No. 967.

CALIFORNIA RAISIN CULTURE.

(Continued from first page.)

period this important industry could be transplanted to distant California and the methods of Spanish cultivators improved in such a measure as to displace foreign importations altogether is another miracle of American enterprise. Spain has still the advantage of cheap labor.

The cultivation of the raisin grape differs in no essential particular from the methods employed in bringing the wine grape to its present perfection in California vineyards, which have been described in detail in previous numbers of the SCIENTIFIC AMERICAN. It is a process of ceaseless industry and never-failing vigilance, the fruit of minute observation and scientific experiment. Beginning in early winter, the vines are pruned close to the ground and each succeeding month, up to the first of June, finds the growers industriously engaged in cultivating, sulphuring and pruning again, with the object of protecting the vines from the attacks of insects or rust and of getting out of the soil and forcing into the maturing fruit the greatest nourishment without at the same time exhausting or weakening the vines. Superfluous bunches are cut off. The size and not the number of these is the aim of the most successful grower.

The climatic conditions in the raisin district are of the utmost importance to the successful prosecution of the industry. The season's rainfall in Fresno averages about 8 inches, beginning in November and terminating in May. But the growers here are entirely independent of nature's supply of moisture. The varieties of grapes chiefly planted are the Muscatel de Gordo, Blanco, Muscat of Alexandria, Sultana and Thompson's Seedless. It takes on an average three and one-half pounds of green grapes to make one of raisins. The yield per acre is about five tons of green, or one and a quarter of the dried fruit.

The average amount of sugar in the raisin grape is from 25 to 29 per cent, depending upon soil, season and amount of water supplied. Vines are planted eight and ten feet apart, and closer when the richness of the soil admits.

The season's gather of the grape begins the latter part of August. There are 43,000 acres of vines in Fresno County, and one man to the acre is the rule. The clusters are handled by the stems alone, as contact with the hands robs the product of its sightliness. As fast as picked the grapes are deposited in trays 2 by 3 feet in size holding about 20 pounds. These trays are laid between the vines, sloping toward the sun. Here they lie for six or eight days, when they are turned over by the simple process of placing one tray on top and reversing. The sun curing takes altogether from ten to twelve days, when the grapes are taken to the packing house to endure the sweating process. The sweat boxes are somewhat larger than the trays, and 8 inches deep. The sun-dried grapes are transferred to these boxes, a sheet of paper being laid upon the bottom and a layer of grapes placed on this, paper and grapes alternating until the box is full. The loaded sweat boxes are then carried to the equalizing room, a dark, air-tight apartment, well ventilated; the boxes are piled on top of each other, and remain for fifteen or twenty days until thoroughly sweated.

In this process the moisture in the raisin is evenly diffused; when the product emerges, it is about ready for market. In handling, much fruit falls from the dried stems and is marketed as "loose." These are put in a "stemmer," where they are divested of the stems and mechanically sorted into four grades. The bunch raisins are generally packed in twenty-pound boxes. This is a careful operation and is generally intrusted to women and girls.

Within the past three or four years a new product known as the California seeded or stoned raisin has been put upon the market, and has rapidly attained popularity among consumers for its many obvious merits.

In 1896, the stoned raisin was put upon the market. The raisins are prepared for seeding by first being subjected to a drying temperature of 140° for five hours, immediately after which the fruit is submitted to a chilling process, and while in this condition is passed through a cleaning and brushing machine, which removes absolutely every particle of dirt, including the cap stems. It is then taken to a room and spread out on wire trays in a temperature of 130° which brings the fruit back to its normal condition. In this process the berry is converted into pectin, that delicious jelly which gives to fruit its best flavor.

The raisins being thus submitted to alternate heating and chilling are prepared to endure all climatic influences and to keep indefinitely. They are then passed through the seeding machines, which have a capacity of from ten to twelve tons daily. In the operations, raisins are pressed between rubber-surfaced rollers, which at first flatten the berry and press the seeds to the surface, when an impaling roller catches the seed between the needles and teeth affixed to its periphery and removes them from the fruit, which passes on, minus only the seed. The product is then packed in one-pound paper boxes and afterward in packages containing thirty-six, convenient for marketing. The extraction of the seeds leaves the fruit intact, without mutilation.

It is expected that Fresno will ship this year about 2,500 carloads of raisins alone.

Engineering Notes.

While boring an artesian well in the exhibition annex at Vincennes, the engineers discovered a thick seam of coal at a depth of about 100 feet. The fuel proved of good quality, and it is thought to be very abundant.

This winter arrangements have been made by which the trip from London to Nice may be made in exactly twenty-four hours, including the passage of the Channel. The distance is 966 miles; this is an hour and 23 minutes faster traveling than the schedule of last year.

The production of zinc constitutes one of the oldest and staple industries of Poland, having been followed since 1816. In that year only 410 tons were produced, which had increased to 5,500 tons in 1898. It is computed that over 250,000 tons of zinc have been produced in Poland since the industry first commenced.

An attempt is being made, under the auspices of the German government, to cultivate the American cotton plant in Togoland, German West Africa. An agreement has been concluded between some planters and experts in Alabama and the German authorities by which 150 carriers and laborers will be taken to the West African colony. The government has encouraged the enterprise to the extent of $15,750, and the Berlin "Colonial Economic Committee" will also render aid to the scheme.

An interesting advertising scheme has been adopted by the Atchison, Topeka & Santa Fé Railway Company. One of their traveling men, an expert stenographer, was sent to visit individual farmers in their homes, to find out what success they were having, and then write letters at their dictation addressed to Eastern friends, telling about the crops, etc. He goes about with a team, and carries a typewriter and stationery. This personal letter is followed up in due time by advertising literature sent to the friends to whom the letters are written.

The Strand district of London disposes of 21,000 tons of refuse per annum from that neighborhood alone. Hitherto this garbage has been conveyed away from the city in barges at a cost of $15,000. With a view to economizing on this expense, a refuse destructor of the Horsfall type has been erected on the south side of the river, at a cost of $50,000. It is calculated that by this development a saving will be effected of over $2,500 per annum after writing off the annual charge for the repayment of capital with interest in ten years. The cost of removing the clinkers by barge will be about $6,000 a year, but it is anticipated that a saving may be made also in this direction, by the preparation of the clinker for building purposes.

Barrow in Furness is rapidly rising in importance as a private naval dockyard, owing to the numerous developments that have been carried out by Messrs. Vickers, Sons & Maxim, Ltd. During the past two years, this firm has expended $6,250,000 for the building of new yards, workshops, and the installation of new machinery. All the gun mountings required for the vessels constructed by this firm at Barrow are now produced upon the spot, as well as projectiles, from 50 up to 850 pounds. The whole of the machinery in the engine section is driven by electricity. At the present time this firm have five ironclads in course of construction for the British navy, of the very latest type, and which when completed will be the largest and fastest armored cruisers in the world. Their displacement will be 14,000 tons, with a speed of 23 knots.

The Bell Telephone Company Wins a Suit.

Judge Coit, of the United States Circuit Court, gave a decision on December 21, in favor of the American Bell Telephone Company, in the suit brought by the Western Union Company to recover a sum said to be due on a division of rentals and royalties, according to the terms of the contract between the two companies dated November 10, 1879. The case has been in the courts for seventeen years, and the amount asked for is said to have been $12,000,000.

Under the contract, the defendant, then known as the National Bell Telephone Company, agreed to pay the Western Union 20 per cent of all rentals or royalties received from licenses for telephones in the United States. The Bell Company issued licenses to various corporations, and received, in addition to the annual rental for telephones, 35 per cent of the capital stock of these corporations. The Western Union held that this stock was "rentals or royalties," within the meaning of the contract, and that it was entitled to 20 per cent of the stock and the dividends declared thereon.

The Bell Company said that the "rentals or royalties" mentioned in the contract were the standard annual rentals (less commissions) and nothing more. A master found in favor of the Bell Company, and the Western Union's exceptions are overruled by Judge Coit.

Science Notes.

During the month of September the slaughter house at Villette, which supplies Paris, dispatched daily an average of 3,044 oxen, 1,041 cows, 23,384 sheep, 2,725 pigs and 2,999 calves. In ordinary times only 1,210 oxen, 450 cows, 13,929 sheep, 4,828 pigs and 1,425 calves are required.

In an account of Manchuria given in Petermann's Mittheilungen, the statement is made that the Manchus are disappearing under the influx of the Chinese, and the time is probably not far distant when their language will cease to be spoken, as their children are taught Chinese.

The medical faculty of the University of Heidelberg has made an interesting report on the effect of the incandescent light, whether gas or electric, upon the eyes. After mature deliberation they have decided that the incandescent light is not harmful, and they specially recommend electricity for lighting halls and places of entertainment.

A scientific expedition is to start from St. Petersburg to examine the immense number of manuscripts discovered at Mukden by Russian troops. In the collection are a large number of Greek and Roman documents, which are supposed to have been taken by the Mongolians on the retreat from the Occident. It is believed that the manuscripts are of great value.

The Alexandra Palace, London, in which the exhibition of 1861 was held, and which was in danger of being sold to the speculative builder, has been secured for the nation, at a cost of $750,000. The palace itself covers seven acres of land, while the whole of the estate comprises 147 acres. The palace is to be opened to the public every day throughout the year. The large banqueting hall will be utilized for Volunteer headquarters, and it is proposed to found a technical institute.

An outbreak of typhoid fever has occurred in Lambeth, England, owing to infected mangles. Forty-one cases occurred in twenty-four houses, all within a restricted area. There was much inter-communication between places and families living in different houses. Many of the inhabitants after washing their clothes in their own homes took them to some neighbor to be mangled. Owing to this custom, bedding and clothing of those ill with typhoid fever were mangled in the same machine, thus spreading the disease. Four different infected mangles were traced.

Prof. Koch, in describing his experiences with the government expedition in Java and New Guinea, stated that he had reached the conclusion that gnat bites introduced and developed parasites into the human body. The germs are passed by a gnat from one human body to another, but they develop in the body of the gnat during the passage. Children are specially liable to impregnation. In a village in New Guinea, 137 inhabitants out of 700 were infected by the disease. All inoculations have hitherto proved to be failures, but the success of quinine is very gratifying.

It has been decided to prolong the period for the competition for the Deutsch prize of $20,000 for a navigable airship for an extra six months, from May 1 to October 31, 1901. It has also been decided by the Aero Club of Paris to carry out a series of monthly balloon ascents under the auspices of the International Aeronautical Committee for Scientific Purposes. The aerostats will ascend from Paris, Trappes, Strasburg, Berlin, Vienna, and Bath, between the hours of 6 and 8 A. M., in order to study the atmosphere and to carry out other meteorological observations. The airships will be provided with automatic registering instruments.

During the recent restoration of St. Martin's Church at Vevey, Switzerland, a primitive edifice has been discovered a few feet beneath the floor of the building. In shape it somewhat resembles a church, but the style of architecture is quite foreign to Europe, but bears traces of Oriental source, somewhat similar to that of the Taj Mahal, Agra, India. The walls and foundations of the relic are in a remarkable state of preservation, and the whole structure is to be carefully excavated, and attempts will be made to determine the epoch to which it belongs. It is believed by experts who have examined the materials of which it is constructed that it is one of the earliest buildings in which stone was employed.

A few weeks ago an old Viking ship was discovered at Tottenham Marshes on the outskirts of London, during some excavations in connection with the new waterworks for the East London Company. Recently another equally interesting discovery was made by the unearthing of a dug-out boat in a remarkable state of preservation. Canoes shaped out of a single tree of the Stone Age have been frequently found in Ireland, and the estuaries of England and Scotland, while some specimens were also discovered during the excavation of the Manchester ship canal. This dug-out boat was found in its natural floating position, not far distant from the spot were the Viking ship was unearthed, about eight feet below the surface. The relic will probably be forwarded to the British Museum.

The Heavens in January, 1901.

BY HENRY NORRIS RUSSELL, PH.D.

The most important astronomical event of the present month, from a scientific standpoint, is one which is observable only by telescopic aid. It is the close approach to our earth of the small planet Eros, and its importance consists in the fact that it enables us to determine more accurately the distance of the sun and the dimensions of our solar system.

In this rather dull season, speaking from the standpoint of the amateur stargazer, it may then, perhaps, be worth our while to devote part of our time to the subject which is now employing the resources of some of the greatest observatories.

The asteroid Eros, which was discovered early in August, 1898, is, in many respects, the most remarkable of all the small planets. It is much nearer to the sun than any other of the asteroids, and its period is correspondingly short. Its mean distance from the sun is about 135,000,000 miles, and it completes a revolution about that luminary in very nearly one and three-quarter years, while the next nearest of the asteroids is 180,000,000 miles distant, and takes a year longer to complete its circuit.

Eros is, of course, nearest to our earth when it is in opposition, that is, when we come directly between it and the sun. If its orbit were circular, this distance would always be the same, no matter what part of its orbit Eros was in, but as a matter of fact the orbit is strongly elliptical, so that the planet is much nearer the sun (and consequently the earth's orbit) at some times than at others. In the most favorable case, when an opposition occurs about January 21, Eros is but some 14,000,000 miles away. No other heavenly body but the moon and an occasional comet can come so near.

At the present time things are not quite so favorable. Eros reaches the point of its orbit which is nearest that of the earth on February 6, while the earth, which passed the corresponding point on January 22, is about 24,000,000 miles further on, and about 28,000,000 miles from Eros. In this part of its orbit Eros moves almost as fast as the earth, so that the two planets keep along for some time at about the same distance, like two trains running at the same speed on parallel tracks, the earth being always ahead, till the curving of Eros' orbit separates the two more widely.

But what has all this to do with the sun's distance? Simply this: we can from a study of the motion of any planet among the stars determine very accurately what ratio its distance bears to that of the sun, without any knowledge of how many miles there are in either distance. For example, it is known that in the middle of the present month the distance of Eros from the earth is almost exactly $\frac{3}{10}$ that of the sun, so if we can find the first, it is a simple piece of arithmetic to get the second. Now the only way to determine the distance in miles of a heavenly body is by a sort of triangulation, where two of our stations are on the earth, and the other on the body whose distance we wish to measure. We know the distance of our two terrestrial stations in miles, and require only to know the angles of the triangle to determine the other sides. But since the body is at a great distance, the angle formed, at the body, by the lines joining it to the two stations on the earth, must be very small; and the greater the distance of the body, the smaller will this angle be. Now if this angle is very small, the unavoidable errors which are present in even the best observations will amount to a large proportion of its value, and the deduced value of the distance of the body will be correspondingly uncertain. So it is evident that the distance of the nearest planets may be determined with the greatest proportional accuracy.

Eros, during the present month, is nearer to the earth than any other planet ever comes, excepting Venus, and when Venus is at her nearest she is between us and the sun, and visible only in daylight, when her position among the stars cannot be accurately measured. Moreover, Eros is too faint to be seen with the naked eye, and appears in the telescope merely as a starlike point of light. It is in consequence much easier to observe accurately than a planet presenting a large disk, like Mars or Venus.

The advantages of observation of Eros are thus twofold: the errors of observation are less than in the case of one of the larger planets; and, since Eros is nearer, equally large errors will produce a smaller percentage of error in the calculated distance of the planet, and in that of the sun, which is deduced therefrom. Indeed, so favorable is the present opportunity that so eminent an authority as Prof. Newcomb has expressed the opinion that the observation of Eros at the present opposition will give us a more accurate value of the sun's distance than all previous similar observations put together.

This then is why a systematic "campaign" of observation is planned by the astronomers of Europe and America, and why a little speck of light, hardly visible in a field glass, has concentrated upon it so large a part of the attention of the astronomical world.

There is little need to spend much time in the description of the heavens this month. Sirius and Procyon are well above the eastern horizon. Above the former are Orion and Taurus, above the latter Gemini and Auriga. Eridanus and Cetus form an uninteresting southern sky. Perseus is near the zenith, and Andromeda and Pegasus below on the west. Of the summer constellations, only Cygnus remains low in the northwest. Cassiopeia is above and to the left of the pole, and Ursa Major opposite and near the northern horizon.

Mercury is morning star until the 21st, when he is in superior conjunction, passing behind the sun and becoming an evening star. He can only be seen, if at all, during the first few days of the month, when he rises about an hour earlier than the sun. Venus is also morning star in Scorpio and Sagittarius. She is moving rapidly eastward among the stars, and is steadily overtaking the sun. She rises about two hours before sunrise on the 1st and one and a half hours on the 31st. Mars is in Leo, and moves slowly eastward until the 13th, when he begins to retrace his path as he approaches opposition. He is rapidly approaching the earth and increasing in brightness. On the 1st he is about 87,000,000 miles from the earth, while on the 31st his distance has decreased to 68,000,000 miles, and he is nearly twice as bright as at the month's beginning. Jupiter is in Sagittarius and is a morning star, rising about an hour before sunrise on the 1st and over two hours on the 31st. Saturn is also in Sagittarius, and, like Jupiter, is moving eastward among the stars, though more slowly. He rises only a few minutes before the sun, at the beginning of the month, but by its close he is far enough from him to be easily seen, rising nearly two hours before sunrise. Uranus is morning star in Scorpio, rising three hours before the sun in the middle of the month. Neptune is in Taurus, well placed for telescopic observation.

The present month is remarkable for the large number of planetary conjunctions that take place. Venus plays the principal part in these. On the 3d she is in conjunction with Uranus, passing north of him at a distance equal to about twice the moon's diameter. But much more conspicuous are her conjunctions with Jupiter on the 15th and with Saturn on the 24th. On the first of these dates she passes north of Jupiter at a distance of about three-fourths of the moon's diameter and on the 2d she approaches a little nearer to Saturn, but on the southern side. These last two conjunctions can be easily seen in the early morning. Mercury also comes into conjunction with Saturn on the 7th, but both planets are too near the sun to be seen.

Full moon occurs on the afternoon of the 4th, last quarter on that of the 12th, new moon on the morning of the 20th, and first quarter on that of the 27th. The moon is farthest from the earth on the 12th, and nearest on the 24th. She passes Neptune on the afternoon of the 3d, Mars on that of the 9th, Uranus on the night of the 16th, Jupiter on that of the 17th, Venus on the forenoon of the 18th, Saturn the evening of the same day, Mercury on the morning of the 20th, and Neptune again on the evening of the 30th.

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Retrospective Views of the Century.

In the last issue of the SCIENTIFIC AMERICAN, we took occasion to publish an interesting review of the century from the pen of Mr. Edward W. Byrn, the author of "Progress of Invention in the Nineteenth Century." The contemporary press have made somewhat elaborate plans for publishing reviews of the century, many of them on a somewhat extensive scale. One series which is in process of publication will extend over a period of many weeks. It is only fair to mention that for nearly two years Mr. Byrn, of the SCIENTIFIC AMERICAN, has been engaged upon the preparation of the work which we mention above. His facilities for reaching the data from which he has obtained the information treated of in "Progress of Invention in the Nineteenth Century" are unsurpassed, owing to his residence in Washington, and his intimate relationship with the Patent Office. Many of the valuable papers which are now being published on the progress of the last century will be scattered and lost, but the work above referred to, which has been extensively and favorably reviewed by the contemporary press, preserves in condensed form a most complete and accurate record of the industrial progress of a hundred years.

Automobile News.

The French Automobile Club, the Belgian Automobile Club, and a union of the automobile clubs of the various centers of Italy have arranged extensive tours for 1901. The French Club will have a three weeks' trip through Tunis; the Italian Clubs will make a tour of the Italian lakes, a distance of 1,000 miles to be completed within 14 days; and the Belgian Club are organizing a jaunt through Namur, Spa, Liege, Antwerp, Bruges, and Ostend.

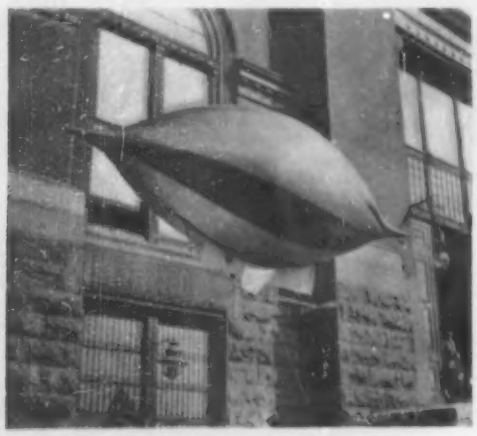
The latest pattern of the De Dion motor tricycle possesses many important improvements. The engine, which is of 2¾ horse power, is so attached as to be free from the machine, so that it remains stationary until the clutch is inserted, by the movement of the lever fitted to the handle-bar. The brakes, which are of great power, are supplied inside the side wheels instead of being fitted to the front wheel as heretofore. The brakes are controlled by a lever fitted to the left-hand side of the handle-bar. The coil is placed at the end of the tank, and not upon the axle bridge, so that short circuit is averted.

One of the interesting automobile events in Paris has been the hill-climbing race lately held at Chanteloup, near Paris, under the auspices of the Moto Club. It was a contest for large machines, and moto-cycles were excluded. Carriages carrying from four to six passengers were entered, besides voiturettes with two and four persons. The slope up which the race was made has a grade of 11 per cent and is about 5,600 feet long. There were more than 40 entries, and many of the well-known "chauffeurs" took part, such as R. de Knyff, Serpollet, Michelin, Georges Richard, Delahaye, etc. Baron Henri de Rothschild entered with his new German-built carriage for four persons, with motor of 20 horse power. There were five sections: carriages of four or six seats, voiturettes (two sections), and light voiturettes. It was an all-around contest, and the points taken into account were not only speed, but horse power of the motor and general performance. All types of machines, petroleum, alcohol, and steam, were represented, but comparison was not made between them, and all were placed on the same footing. The following is a list of the winners in each of the five classes, with the time of each: 1. Carriages of 4 places, H. de Rothschild, time 3 min. 45 4-5 sec., or 17·5 miles an hour. 2. Carriages of 6 places, Lefebvre, 5 min. 10 sec., 12·5 miles an hour. 3. Voiturettes of 2 places, Mercier, 4 min. 8 4-5 sec., 16 miles an hour. 4. Voiturettes of 4 places, Darracq, 5 min. 57 3-5 sec., 11 miles an hour. 5. Small voiturettes of 2 places, Gladiator, 5 min. 56 1-5 sec., 11 miles an hour. After the race Marcellin made a trial of the course on his racing machine and covered the distance in 3 min. 4 4-5 sec., but as his machine belonged to the moto-cycle type, it was not entered officially in the race.

The Bulletin of the Société des Ingenieurs Civils gives an account of the progress of the automobile industry in Germany. This country, in which were developed the first two motors for automobiles, the Daimler and the Benz, has been much slower than France in the development of the industry, and a large part of the German vehicles are of French importation for the petroleum types and of American for the electric. Nevertheless, the construction of automobiles has made a great stride forward within the last year or more. Nearly all the bicycle works have, as in France, undertaken the construction of moto cycles, and in most of the large cities may be seen a considerable number of moto-cycles for package delivery with De Dion or Astor motors. The two leading German constructors are the Daimler Company, which constructs machines having figured well in many of the races and whose works at Cannstadt are in full activity, and the Benz Company, which produces motors of a horizontal type with one cylinder, which it exports to France and England. At Hamburg have been noted a certain number of Daimler vehicles, and those of Moritz-Hille, of Dresden, of a similar construction. A number of electric cabs have been recently put in service as well as an electric omnibus system. At Berlin is to be seen the large omnibus of Siemens & Halske with an accumulator system, and also a wire-loop trolley, by which it travels upon the electric tramway lines or independently; it contains eighteen places. The General Omnibus Company has recently established a line of these vehicles between the Stettin and Anhalt depots, about three miles distant; the trip is of half an hour, and the price is ten pfennigs. The same company constructs also a hotel omnibus for nine persons, besides delivery wagons and electric cabs. At Cologne may be mentioned the Henry Scheele Company, which constructs electric hauling wagons of five tons capacity; they are provided with electric motors of six horse power each, and give a speed of over four miles an hour, being able to cover a distance of eighteen to twenty miles without recharging.

SOME INTERESTING EXPERIMENTS IN DIRIGIBLE AIRSHIPS.

Some interesting experiments with small dirigible airships have recently been carried out by Carl E. Myers, of Frankfort, N. Y. A short time ago he had two dirigible airships on exhibition at the Coliseum at St. Louis, and eight performances were given each day. The two vessels were the "Electric Aerial Torpedo" and the "Sky-Cycle Airship." The Coliseum has an oval arena of 222 feet long, 112 feet wide and 60 feet high, surrounded by seats, boxes and two galleries, and overhung with many swinging electroliers, wires, ropes, and deep iron girders bracing the roof, while on the ground space was an electric fountain, 30 feet in



CARL E. MYERS' ELECTRIC AERIAL TORPEDO.

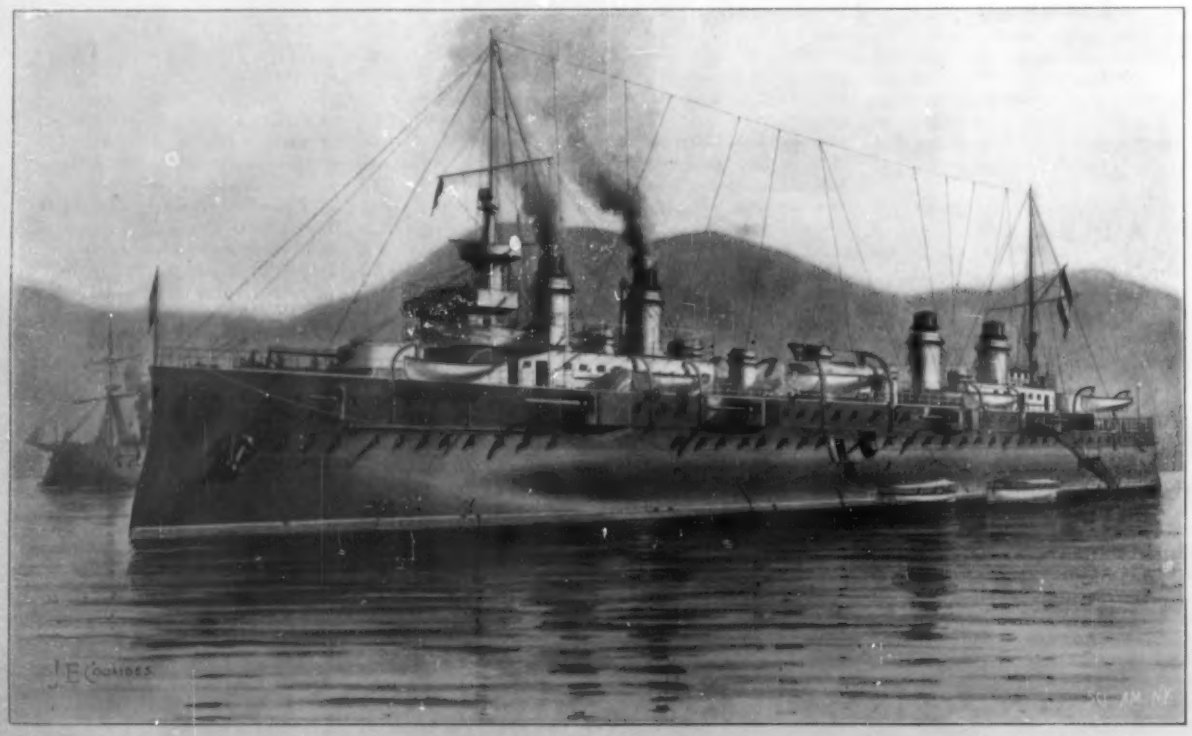
diameter and 20 feet high, which contracted the narrow passage-way on each side of the oval. The torpedo was of entirely new design and is shown in our engraving. It was propelled by a 1½ horse power electric motor, weighing 4 pounds, the current being at 110 volts, and it was controlled from a switchboard. The torpedo was thirteen feet long from tip to tip, and its circumference was the same. The keel attached below supported a car containing a motor, an aluminium screw shaft and a two-bladed propeller; two aeroplanes assisted to support and guide it in mid-air. The small vessel usually started from its elevated platform across the arena, rising as it flew, and then turning gradually about and retracing its course, then curving and gradually rising until it reached the ceiling on a spiral pathway. The vessel then fell vertically until it reached the ground; it then rose and circled again in a path limited by the arena until part way around the oval, when it described a figure eight and flew off on another tack and re-encircled the oval with an opposite succession of cycloidal curves, pausing occasionally with an opposite succession of cycloidal curves, pausing occasionally within reach of the spectators to permit an inspection of its working parts. It would then suddenly fly around the arena, darting straight at some selected victim, but when just within reach it would circle to the right or left or else swing broadside. It would often rest itself for a moment on the railing of the boxes, then fly to the electric fountain and circle it, and then move forward in a straight or curved course. The purpose of the electric aerial torpedo was to demonstrate the ease with which war vessels of this type might be propelled and controlled, and high explosives be distributed over any point selected for destructive purposes.

A HUNDRED feet of the dam of the electric power house at Chambly was swept away on November 16, completely demolishing the fifteen sluices. The damage to the Richelieu woolen mills was very great.

THE FRENCH ARMORED CRUISER "MONTCALM."

The rakish-looking craft which forms the subject of the accompanying illustration is one of three powerful armored cruisers which are now under construction for the French navy. These will be known as the "Montcalm," the "Gueydon" and the "Du Petit-Thouars." The "Montcalm," which was launched during the past year, is a fine representative of that armored cruiser type the beginning of whose present popularity may be traced to the advent of the justly celebrated cruiser "Dupuy de Lome," which was entirely clothed with armor from top deck to waterline. The armored cruiser is certainly one of the most, and many people believe the most, important fighting and tactical element in modern naval fleets; and as the French may be said to have originated the type, at least in its later form, so they had been the foremost in its development and in the numbers of the type which they have put afloat. Great Britain, ever conservative, clung tenaciously to the protected cruiser and was slow to follow, as she has in her past history so often followed, the lead of her neighbor and most active naval competitor across the English Channel. To-day Great Britain is building armored cruisers of high speed at a rate which must soon give her a preponderating number of these fine vessels; for she has no less than fourteen of this type, of from about 10,000 to 14,000 tons displacement and 21 to 23 knots speed, at present under construction.

The "Montcalm" is 453 feet in length, 63 feet 8 inches in beam, draws 24 feet 7 inches, and at this draught displaces 9,517 tons. She is propelled by triple screw engines of 19,600 horse power at a maximum speed of 21 knots an hour. Her normal coal capacity is 1,030 tons and her total bunker capacity is 1,600 tons, and in these totals is included a certain amount of liquid fuel. The motive power is thoroughly up to date, the steam being furnished by batteries of Normand-Sigandy water tube boilers. The vessel is protected at the waterline by a practically complete belt of Harvey steel, which is 6 inches in thickness amidships and tapers to 3¾ inches in thickness at the bow and stern. For a little over a quarter of her length, commencing from the bow and running aft, the waterline belt is carried up to the main deck. Associated with the belt is a 2-inch armored deck, and the various gun positions of the casemate or turret type are protected by Harvey armor which varies in thickness from 3¾ to 8 inches. There are two submerged torpedo tube dischargers. The armament consists of two 7·6-inch breechloading rifles carried in two turrets, one forward and one aft on the center line of the vessel, both upon the spar deck; eight 6·4 inch rapid-fire guns mounted in sponsons on the broadside on the main deck, the two forward and after guns being capable respectively of dead-ahead and dead-astern fire; four 3·9-inch rapid-fire guns, mounted in broadside on the spar deck; and sixteen 3-pounders and six 1-pounders which are carried in convenient positions throughout the superstructure, the bridges and the fighting tops. The "Montcalm" is modeled above the waterline with the characteristic tumble-home that is seen in so many of the French vessels; but we miss in her the exaggerated ram bow which one has learned to associate with the French cruisers of former years. The total complement of the ship is 612 officers and men, and it is probable that the great length of the vessel will enable the crew to be very comfortably berthed.



NEW FRENCH ARMORED CRUISER "MONTCALM."

Displacement, 9,517 tons. **Speed,** 21 knots. **Maximum Bunker Capacity,** 1,600 tons. **Armor:** Belt, 3¾ to 6 inches; gun positions, 3¾ to 8 inches; deck, 2 inches. **Armament:** Two 7·6-inch; eight 6·4-inch; four 3·9-inch; sixteen 3-pounders, six 1-pounders. **Torpedo Tubes,** 2. **Complement,** 612.

A SAFETY MILITARY SPY-GLASS.

The ordinary telescope and spy-glass which military officers have used for more than a hundred years is gradually giving place to an instrument far more

Fig. 1.—STEREOSCOPIC MILITARY FIELD-GLASS.

powerful and less likely to expose an observer to the long-distance fire of an enemy. The list of dead and wounded sent home from South Africa shows that the modern high-power magazine rifle has rendered the lot

Fig. 2.—THE FIELD-GLASS IN USE.

of the commanding officer far more hazardous than it once was. This increased danger and the great ranges at which modern battles are fought have been the chief reasons why the ordinary spy-glass has been found inadequate by the modern army officer.

The new instrument consists of two tubes hinged together and carried by a central handle. Each tube is provided with an objective and with an eyepiece. By means of a system of total-reflection prisms the image formed by the objective is so deflected that the eyepiece, mounted at right angles to the tubes, may properly present it to the eye.

When the instrument is open, the distance between the two objectives is about sixteen inches. The lenses and tubes are so arranged that a stereoscopic effect is obtained.

In order to make use of the stereoscopic spy-glass, the eyepieces are first purposely focused. Since, in the majority of cases, both eyes of the same person are not equal, the two eyepieces are focused independently. The instruments are regulated for a 2·6 inch spacing of the eyes, which is the average. For persons having eyes differently spaced, there is a very simple mechanism for regulating the

apparatus. A marking arrangement permits of making such regulations once for all.

The stereoscopic spyglass may be employed in two different positions of the telescopes, one nearly horizontal and the other nearly vertical.

The first position, as in Fig. 1, increases the spacing of the eyes through an optical illusion. In this position of the telescopes remote objects situated in different planes can be seen. The second position (Fig. 2) increases (artificially likewise) the stature of the observer. In both cases, the observation may be made from a place of concealment. For the horizontal position of the telescopes, the observer merely takes shelter behind a tree and allows the ends of the instrument to project behind the sides of the tree. Fig. 2 needs no comment. The observer can calmly make his observations while concealed behind a wall, with the two extremities of the apparatus carrying the objectives projecting above the obstacle.

It is hardly necessary to dwell upon the utility of the instrument from a military point of view. From a very interesting report made by Lieut.-Col. Becker, of the Swiss army, we select the following passage: "With a common ordnance fieldglass we observed, at a distance of about two miles, a trigonometric signal situated at the same height as ourselves and on the verge of a forest. It was impossible to recognize whether this signal was upon the very outskirts of the forest or remote therefrom. Upon making the same observation with the stereoscopic spyglass, the signal appeared remote from the edge of the forest, and it was possible, besides, to estimate the distance that separated it therefrom at 40 or 50 feet. The artilleryman will at once recognize the advantages that may be derived from so precise an observation."

The instrument under consideration magnifies ten times and embraces a linear field of 65 yards. Its weight is about a pound and a half, and it may be easily carried in a case.

THE BOLOMETER OR ACTINIC BALANCE.

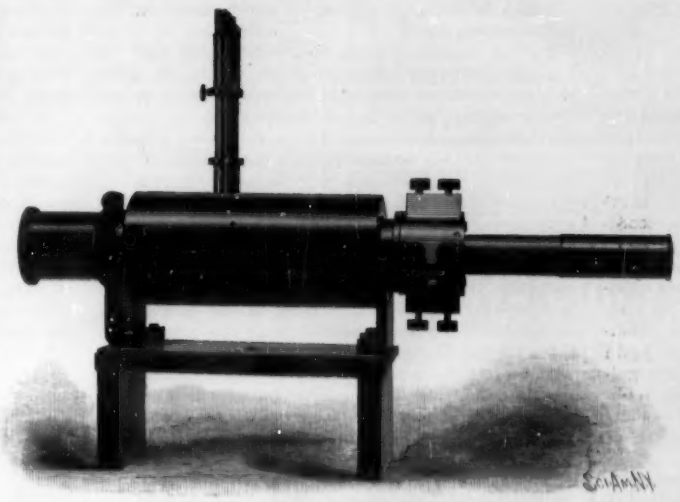
BY MARCUS BENJAMIN, PH.D.

In the domain of astronomical physics American scientists hold a foremost place, and among those who have devoted their attention to that branch of science, Samuel P. Langley has been accorded the highest honors.

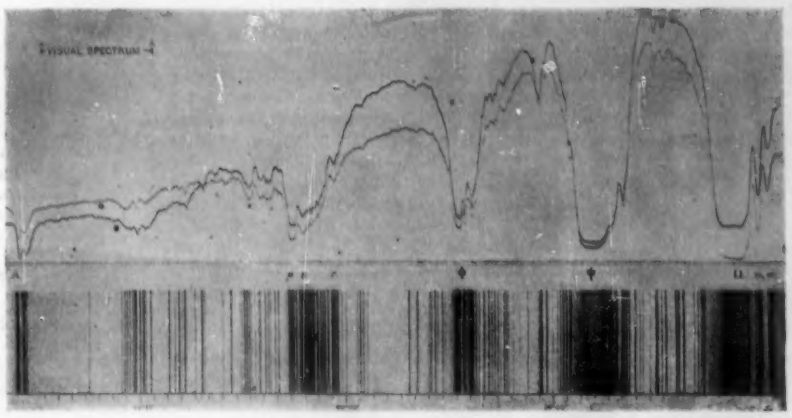
In 1867 Dr. Langley was called to the charge of the Allegheny Observatory in Pittsburg. The obscured condition of the atmosphere, due to the smoke from the many large metallurgical and other industrial establishments in the vicinity of that city, made it practically impossible to study the smaller heavenly bodies, and he naturally turned his attention to the sun, beginning almost at once that brilliant series of investigations with which his name has been so honorably connected.

As has been indicated, it was doubtless the atmospheric conditions that surrounded Pittsburg that led Dr. Langley to devote his attention to the sun, and it seems equally probable that it was these conditions that influenced him to investigate the physical conditions of that great orb. But even physical conditions may be differentiated, for to be exact, it was chiefly with the amount of light and heat radiated from the sun that he occupied himself.

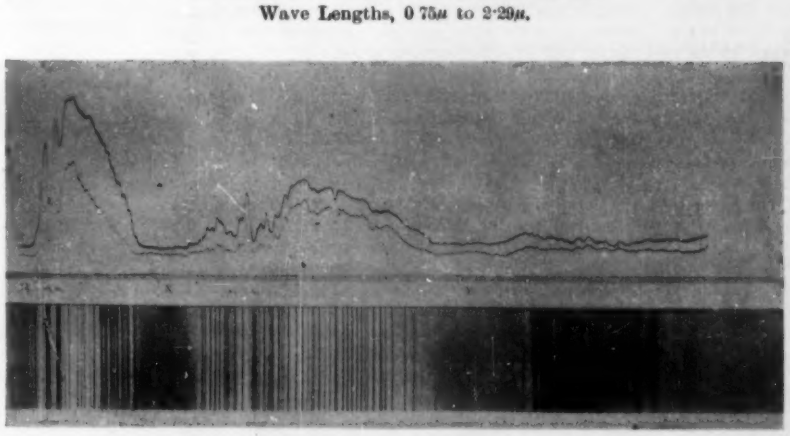
In February, 1874, he published his first paper on the sun, and in it he described in minute deta[illegible] general solar surface and the extraordinary sun spots. Four years later, in discussing the temperature of the sun, he compared the heat and light of the sun to that of molten steel in a Bessemer converter, and at the same time showed that the temperature of the sun was very much greater than 1500° C., which was the temperature usually accepted by men of science. These results were obtained by means of a thermopile, which was the most delicate instrument then known for measuring radiant energy. It became manifest to Dr. Langley that an apparatus more sensitive than the thermopile, and which at the same time should be more accurate, would be of the utmost value in such investigations. What was needed, he said, was "a measurer of radiant energy, and not a mere indicator of the presence of feeble radiation." Aided by a grant from the Rumford Fund of the American Academy of Arts and Sciences, he set to work in December, 1879, to invent an instrument that would yield the desired results.



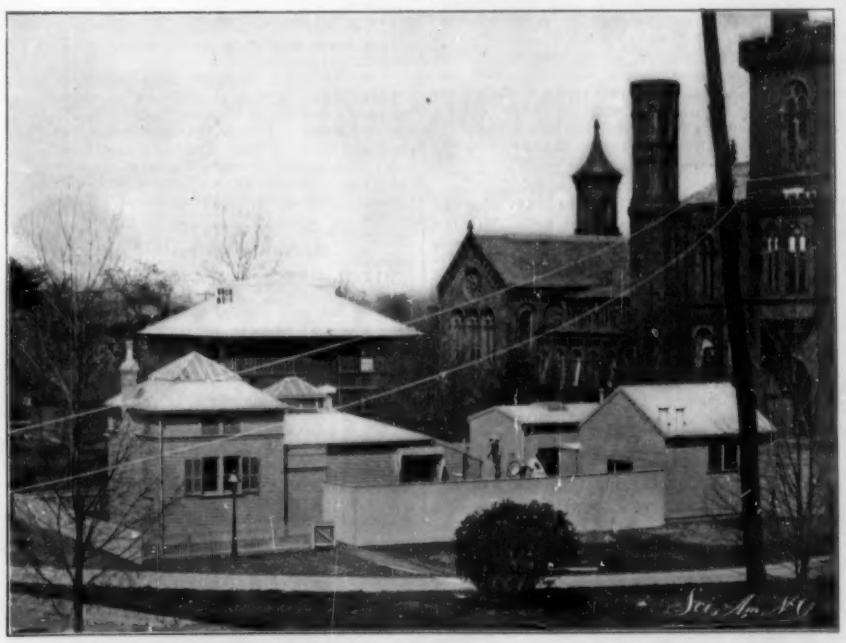
DR. LANGLEY'S BOLOMETER.



INFRA-RED SPECTRUM OF ROCK SALT PRISM.
Wave Lengths, 0·75μ to 2·29μ.



INFRA-RED SPECTRUM OF A ROCK SALT PRISM.
Wave Lengths, 2·00μ to 5·09μ.



THE ASTRO-PHYSICAL OBSERVATORY OF THE SMITHSONIAN INSTITUTION, WASHINGTON, D. C.

His earliest design consisted of two strips of thin metal placed side by side in conditions of environment as nearly identical as possible and in such a manner that one strip could be exposed at pleasure to the source of radiation. When warmed by the radiation, the electrical resistance of the strip exposed increased proportionately over that of the other, and this increased resistance to the flow of the current from a battery could be measured by a galvanometer.

Having thus determined the nature of the instrument to be used, the next step was to study the best method for its manufacture, and in this much time was consumed in experimenting. To secure a radiating body that would not vary from one experiment to another, or from day to day, was the first problem to be considered, and it was not an easy one. He decided to employ the flame of a petroleum lamp within a glass chimney, the radiation being limited by a circular opening of one centimeter diameter in a triple cardboard screen.

With this lamp he tested various metals, such as gold foil, platinum foil, and various grades of platinum wire, gold leaf gummed on glass, extremely thin sheet iron, and the same metal blackened with camphor smoke. The size of the strips was also carefully studied, and he found after much painstaking work that the best results were obtained with an instrument which he described somewhat as follows:

Metallic steel, platinum or palladium are rolled into sheets of from $\frac{1}{100}$ to $\frac{1}{1000}$ of a millimeter in thickness, and from these sheets strips one millimeter wide and one centimeter long, or less, are cut. These strips are then united so that the current from a battery of one or more Daniell's cells shall pass through them. The strips are in two systems, arranged somewhat like a grating; and the current divides, one-half passing through each. When the two currents are equal, the needle of a delicate galvanometer will not be deflected; but when radiant energy in the form of heat falls on one of the systems of strips and not on the other, the current passing through the first is diminished by the increased resistance; and, the other current remaining unaltered, the needle is deflected by a force due to the battery directly, and immediately to the feeble radiant heat, which by warming the strips so little as $\frac{1}{10000}$ of a degree Centigrade, is found to produce a measurable deflection.

So delicate was the instrument thus added to the tools of science that it was said by Dr. Langley that "a change in the temperature of the metallic strips of one hundred-thousandth of a degree can, I believe, be thus noted;" and it is evident from

the excessive thinness of the strips that they take up and part with the heat almost instantly.

The sensitiveness of the instrument depends naturally upon the amount of current used. With the current which experience recommended as leaving a very steady galvanometer needle, it was found that the bolometer showed a sensitiveness of from ten to thirty times that of the most delicate thermopile, area for area.

At first, when the instrument was used, two observers were required, one of whom was occupied in recording the reading of the circle which fixed the place of the bolometer in the spectrum, while the other sat at the galvanometer and noted through how many divisions of the scale the needle swung, owing to the electric disturbances. This process was exceedingly tedious, and involved going over the work again and again with almost interminable repetition; indeed, the galvanometer had to be read over a thousand times to obtain with sufficient accuracy the position and amount of a deflection of the energy-curve in any single part of the invisible region.

As an illustration of the slowness of the process, Dr. Langley said that "it took nearly two years to fix the position of twenty lines" in the spectrum.

Some years afterward Dr. Langley was called to the Smithsonian Institution, and there organized the Astrophysical Observatory, in which the work of examining the infra-red portion of the spectrum by means of the bolometer was continued. He then introduced a method by means of which the work could be carried on not only with far greater rapidity, but with greater certainty, and by an automatic process. Briefly, it was as follows:

Originally, as has been said, the deflection of a spot of light upon a scale was read by one observer, while another simultaneously read the position in the spectrum of the line that caused the thermo electric disturbance. In the automatic form a photographically sensitive plate was substituted for the scale on which the light was deflected, and both observers were dispensed with. As the needle swung to the right or left, the spot of light would trace upon the plate a black horizontal line, whose length would show how far the needle moved and how great the heat was which originated the impulse. If no other conditions intervened, an impulse originated by the movement of the spectrum over the bolometer thread when the needle swings a second time, it will go over the same place; but if the plate be provided with clockwork so as to produce a uniform vertical movement of the spectrum, the combination of the two motions of the needle and the plate will trace upon the latter a sinuous curve which will be, in theory at least, the same as the curve formerly deduced from thousands of galvanometer readings.

If we assume that the movements of the invisible spectrum as well as of the plate are controlled by the same clockwork, so that the spectrum is caused to move uniformly over the bolometer thread, and that these movements are by accurate mechanism rendered absolutely synchronous with those of the moving plate, it is evident that not only the amount of heat, but also each particular position in the spectrum of the thread of the bolometer which can alone correspond with any given inflection of the curve, can be deduced from the photographic curve traced on the moving plate.

To this automatic form of bolometer the name of "spectro-bolometer" has been given, and as the principle on which the apparatus was constructed may not clearly indicate its method of manipulation, the following description, taken from Dr. Langley's own account, is added. It may be said that the installation has reference to the Smithsonian Astrophysical Observatory, where for some years it has been in active use.

He says: "A beam from the mirror of the siderostat is conveyed through the slit of a telescope having a rock salt objective of about ten meters focal length to the prism, which is mounted on the massive spectro-bolometer, the novel feature lying in the mechanical connection of the large circle carrying the prism with a distant photographic plate susceptible of vertical motion and taking the place of the scale formerly in front of the remote galvanometer, both circle and plate being now moved by the same clockwork through a continuous train of shafting, which works with such steadiness and precision as to make the two movements entirely synchronous."

To understand this better, let us suppose that the very slowly moving circle carrying the prism moves the spectrum through one minute of arc in one minute of time, across the vertical bolometer thread. To the observer watching the spectrum the motion is as slow as that of the hour hand on the dial, but it is continuous and uniform, and the same mechanism which causes this motion of the spectrum of one minute of arc in one minute of time causes the photographic plate to move vertically before the galvanometer mirror at any given rate; for instance, at the rate of one centimeter of space in one minute of time. It follows that during every second of this minute a portion of the spectrum represented by one second of arc will have glided before the bolometer thread, and that during this same second the photographic plate will have been lifted automatically through one-sixtieth of a centimeter in space; the essential thing being that the plate shall show, on simple inspection, not only the inflection of the energy curve there written down, but the exact relative position in the distant spectrum which the bolometer thread occupied at the moment it caused the disturbance. By suitably changing the wheels on the clockwork we may cause the spectrum to move fast or slow, in the former case giving only its principal inflections, in the latter case giving a great deal more of detail, but with liabilities to error.

It is with this instrument that for nearly ten years persistent work in the examination of the infra-red solar spectrum has been carried on. This extended research is now fast drawing to a close, and in the last annual report submitted by Mr. Abbot, who, under Dr. Langley, has charge of this work, may be found the following summary of the results obtained. He says: "While our knowledge of the infra-red still remains less complete than that of the visible spectrum, both in the number of absorption lines mapped and in the accuracy of determination of their wave lengths, yet the difference in the methods of observation must be recalled. On the one hand are the most powerful gratings with all the advantages of direct photography, while on the other is only a simple prism, in whose dark spectrum we grope for cold lines and measure their wave lengths indirectly. The results of the latter process are 750 lines determined in wave lengths to an accuracy of three parts in ten thousand, and besides—what photography does not give—an exact knowledge of the distribution of the sun's energy."

At the recent eclipse of the sun the bolometer was used in connection with the observations made, and the heat of the corona was, for the first time, successfully observed. The apparatus used by Mr. Abbot was so sensitive that the observer's hand, at distance of five feet, gave a deflection of the galvanometer of sixty scale divisions.

In conclusion, I am very glad of this opportunity to express my appreciation of Secretary Langley's courtesy in allowing me to use the prints from which the illustrations that accompany this article were made.

The Current Supplement.

In the current issue of the Scientific American Supplement will be found, among other articles, a well illustrated description of some Roman amphitheaters and an account of trade in ancient Assyria, both of which should prove of interest to those of our readers who have an archæological bent. "The Aquarium at the Paris Exposition" is the title of an article which describes the remarkable work of MM. Albert and Henri Guillaume. The well-known chemist Berthelot tells of the experiments which he has conducted for the purpose of determining when and why potassium chlorate explodes. In an illustrated article on the "Metallurgical Uses of Aluminium," the Goldschmidt process of industrially utilizing the chemical reaction of aluminium on metallic oxides is described at length. The process has attracted no little attention both here as well as abroad. The Thomson-Houston underground trolley, recently opened for service between Place Pereire and Montmartre, in Paris, is illustrated and described. "Clockwork at the Exposition of 1900" is the title of an illustrated account of some horological curiosities. The address delivered by Mr. H. W. Jane on the "Present Condition of the Coal-Tar Industry," before the Philadelphia Section of the American Chemical Society, is published in full. Mr. H. C. Weeks exhaustively discusses the "Extermination of Malaria-Breeding Mosquitoes by Petroleum and Drainage." The new rattler for testing paving-brick and the improved impact testing-machine which have been installed at Purdue University are described and pictured in a paper contributed by Prof. William K. Hatt and W. P. Turner. The turbines exhibited at the Exposition are discussed and illustrated in a well-written article. How structural iron is cut by the electrical arc is told by J. R. Cravath. The consular and trade notes will be found in their usual places.

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RECENTLY PATENTED INVENTIONS.

Engineering Improvements.

ROTARY ENGINES.—Abram L. Scudder, Deposit, N. Y. In the annular casing of the engine is a steam-chamber. The casing is provided with inlet and exhaust ports and with a slot for the piston-disk, having a head filling the steam-chamber. An abutment slides in guides in the casing. A cam-disk is mounted to turn with the piston-disk and is engaged at its free end by a pivoted lever. A rock-shaft has arms connected with the upper end of the lever and with the abutment. The valve for the admission of steam is opened for approximately one-half the rotation of the piston-disk and is then closed for the other half of the rotation, whereby the steam which has been admitted is expansively used. The amount of the steam in each chamber may be varied by altering the shape of the cam so as to hold the valve open for a longer or shorter time.

CHECK-VALVE.—Thomas J. Hackett, Wardner, Idaho. The check-valve comprises a valve body having an inlet and an outlet, between which is a conical valve-seat. Caps screwed in the body have elongated, inwardly projected tubular bearings or guideways. In one of these guideways a stem is received; and the other guideway receives a second stem, which has a flange and a threaded end, screwing in the conical core of a valve provided with an integral flange. A conical ring of flexible material fits on the valve-core, between the flanges. The valve is made preferably in sections to permit the convenient removal of the ring.

VALVE FOR PUMPING-ENGINES.—James S. Atkinson, 901 Twenty-sixth St., Louisville, Ky. The inventor has devised a valve and a steam-chest having a flat base provided with central and end ports and with a curved exhaust passage formed as a groove in the base. A piston and cylinder have a flat top provided with steam-passages, some of which are formed as grooves extending in the flat top. The passages are arranged to coincide and communicate with those of the steam-chest base. The piston-valve acts automatically to allow alternate induction and exhaust of steam to and from the piston cylinder through the proper passages, and is itself acted on by live steam and thereby shifted at each half reciprocation, so as to cut off steam at the right moment. The formation of the passages as grooves effects a considerable economy in the construction of the engine, as compared with cored castings.

Electrical Apparatus.

ELECTRICAL CONNECTION.—William Gerhardt, Hazleton, Penn. It is the purpose of this invention to provide a convenient device for facilitating the connection or disconnection of electrical wires. The electrical connection has two insulating sections, one being provided with a projection and the other with a cavity in which the projection is received. Oppositely-disposed dogs are carried by the section having the cavity, and work through the walls to engage with the projection of the other section so as to hold the two sections together. Electrical conductors are carried in the sections and are in contact with each other when the sections are engaged.

ELECTRIC SWEEPER AND DUST GATHERER.—Corinne Dufour, Savannah, Ga. In the casing of the sweeper rotating brushes are arranged which are driven by an electric motor. Above the brushes is a suction-fan also driven by the motor and serving the purpose of throwing the sweepings and dust upwardly against a screen containing a sponge or moistened cloth. The arrangement is such that the motor can be readily moved when the machine is not to be used as a sweeper. If the device is to be used for street cleaning, a scraper is added which serves the purpose of loosening the dirt on the street surface. If the device is to be used in hospitals or hotels for cleaning hard wood or tile floors, a rotating mop is employed on the outside of the casing.

INSULATOR.—Emil Rösler, Freiberg, Baden, Germany. The insulator consists of a pin; a lower insulating piece designed to fit over the reduced and screw-threaded end of the pin; and an upper insulating piece comprising a part having a central bore and a screw-threaded metal lining inserted in the bore. A cap is cemented both to the upper insulating piece and to the lining. The upper insulating piece is adapted to screw on the threaded end of the pin and to clamp an electric wire between itself and the lower insulated piece.

Mechanical Devices.

WINCH.—Robert A. McLeod, Kaihu, Auckland, New Zealand. This improved winch is a direct fair-lead winch, which, when swung around at the required angle, hauls, lifts or lowers loads directly without the use of lead-locks. The invention comprises a winch-barrel driven by vertical gear-wheels from a main horizontal gear-wheel, which is movable on a circular guideway bolted into a frame, so that the winch can be turned through a portion of a circle. A pull-back drum operated by gearing, and a horizontal capstan or gipsy, are provided. A vertical shaft carries a capstan or gipsy on its upper end and is secured to the main horizontal gear-wheel. By means of clutches the vertical gear-wheels can be thrown out and the winch held in horizontal adjustment.

LUBRICATING APPARATUS.—Leon Serpollet, Paris, France. The invention is a mechanically operated lubricator of the kind in which oil is drawn from a reservoir by a piston and delivered to the parts to be lubricated through distributing-pipes. In the present invention a piston is provided, which is designed to be simultaneously rotated and reciprocated in a cylinder attached to the reservoir, so as to lubricate without the intervention of suction or pressure valves. A device is also provided whereby overpressure is avoided if the apparatus be used for lubricating under pressure.

Designs.

SMOKE-PIPE REGISTER.—George Kessler, Brooklyn, New York city. The leading feature of the design consists of a rim joined by openwork with a solid ring and a center-piece set in the ring.

COLLAR-PROTECTOR.—Louise R. Sewward, New Brighton, Richmond, N. Y. The shape of the collar-protector is that of an elongated oval, both sides being convex and one somewhat flatter than the other. The side which is least flat has in its middle a V-shaped notch resolving the two portions of the collar-protector into halves in which all the marginal lines are convexed or inwardly curved lines, terminating at the ends in sharply rounded corners.

TROUSERS HANGER.—Timothy B. Shuman, Tyrone, Pa. This device consists of a semi-circular portion formed with a stout spring wire having a bend or loop at one side of the middle for attachment to a nail or hook. Two pairs of jaws are provided, one pair being attached to each end of the wire and having teeth designed to grip the trousers legs at opposite points.

PRINTING-FILM.—Benjamin Day, Hoboken, N. J. This printing-film for printing skies on photographs has a series of dots arranged irregularly. Novel and valuable results are claimed for this film.

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Notes & Queries

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References to former articles or answers should give date of paper and page or number of question.

Inquiries not answered in reasonable time should be repeated; correspondents will bear in mind that some answers require not a little research, and, though we endeavor to reply to all either by letter or in this department, each must take his turn.

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(8020) S. E. D. asks: What would be the proper lengths of the tubes mentioned in the SCIENTIFIC AMERICAN of November 24 for a full set of chimes of ten notes? Will the tubes give as clear a tone as bells of the same pitch? A. The lengths cannot be given exactly on account of the variation in diameter and thickness of the tubes. They can be cut off a little longer than the length given and turned by filing the ends. We give the lengths of fifteen tubes in inches: G, 11½; A, 11; B, 10¼; C, 9⅞; D, 9⅜; E, 8⅞; F, 8⅜; G, 8⅛; A, 7⅝; B, 7¼; C, 6⅞; D, 6½; E, 6⅛; F, 5⅝; G, 5½. The tubes are ⅝ in. external diameter and 1-32 in. thick.

(8021) H. S. G. asks: Is water a conductor or a non-conductor? A. Water is a non-conductor of electricity. It has a very high resistance when pure. The addition of a trace of an acid will, however, reduce the resistance so that it will conduct fairly well. When this is done electrolysis takes place.

(8022) H. H. G. asks: Can you tell me if I should shellac the plates of a Wimshurst machine which I am constructing? I am making the plates of hard rubber and they are eight inches in diameter. A. It is well to shellac the plates of a Wimshurst machine, even if of hard rubber, since the shellac prevents the deposit of moisture from the air upon the plates.

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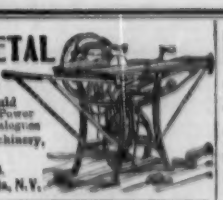

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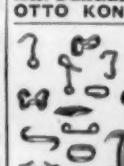

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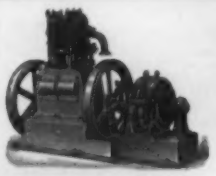

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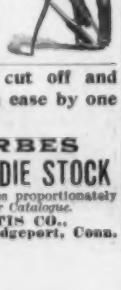

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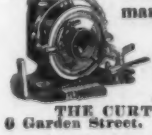

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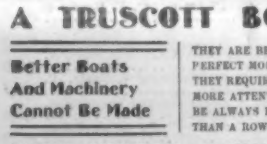

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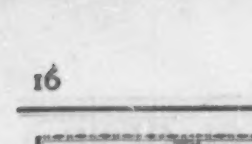

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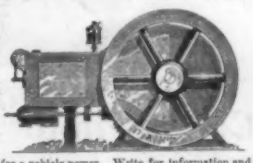

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